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EFFECT OF STOCKING DENSITY ON THE SURVIVAL RATE AND GROWTH TRAITS OF COMMON CARP CULTURED IN RICE FIELDS IN IRAQ

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Abstract

This study was conducted for the period from 15/6/2019 to 1/12/2019 to investigate the possibility of applying the fish culture system in rice fields in Iraq, with determining the optimum stocking density for fish. Different densities of common carp (*Cyprinus carpio* L.) were cultured in 4 rice fields, each field area was 100 m^2 with dimensions of 10m × 10m. The four rice pads were implanted during the summer season of 2019 using the dry method with Yasamin rice species (*Oryza sativa*). After the height of the rice plants reached 20cm the immersion stage started and fish were added inside the rice fields. Four different stocking densities were used (0, 50, 100, 150 fish/field) with an average weight of 50 ± 3 gm/fish. Experimental fish were fed on a submersible diet containing 25% protein. Results showed that the second treatment with lower stocking density (50 fish/field) was significantly higher ($p < 0.01$) than the third treatment with medium stocking density (100 fish/field) and the fourth with higher stocking density (150 fish/field) in regard to studied traits: final weight, total weight increase, daily growth rate and survival rate.

Key words: different stocking densities , common carp, rice fields, survival rate

Introduction

Fish has an important role in providing the world with meat as it is priced reasonably compared to other types of meat and have high nutritional value (Tibbets, 2001). In addition to the importance of fish in achieving food security, rice is an important yield globally, has diversified varieties which occupy an area estimated at 150 million hectares around the world, and unlike other cereal crops it is devoted almost exclusively to human nutrition, it is a source of carbohydrates and there is the main element in food for more than half the world's population especially in Asia (Frei and Becker, 2005). Therefore, the increase in production of fish and rice requires an increase in the allocated lands and to guarantee the optimal and effective use of the available lands and resources in agricultural production and because it is equally important to achieve food security in the world (Dey *et al.,* 2013). Therefore, there is a need to reconsider the current agricultural systems and work to spread and adopt agricultural systems that ensure the achievement of environmental safety and preserve the general health of the human kind, so the tendency was to limit the use of chemical fertilizers and pesticides through the application of the fish culture system in rice fields which is one of the culture systems that achieve this goal (Johnston *et al*., 2009). this system of agriculture acquires great importance through the production of animal protein at cheap prices especially in countries that suffer from a shortage of animal protein , in particular since rice is grown in large areas which maximizes fish production produced in the same environment, as well as being one of the methods used in many countries to develop the economic side, which can contribute to achieve self-sufficiency in fish protein especially in poor countries (Dabbadie and Mikolasek, 2017). The spread of the fish culture system in rice fields in Iraq needs a lot of studies and research necessary to determine challenges and limitations under the Iraqi situation and how to overcome these challenges. Due to the lack of studies of this type, the current study conducted to test the possibility of applying the fish culture system in rice fields as it is used in many other countries of the

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world successfully and has not yet been used in Iraq with determination of the optimum stocking density for common carp fish that can be grown in rice fields, as well as a study of rice yield production without the use of chemical fertilizers and reliance on fish waste and unused food residues as organic fertilizer for rice fertilization process.

Materials and Methods

Site of the study

This study was conducted at Research Station of the College of Agricultural Engineering Sciences, University of Baghdad, Al-Jadriyah From September to December 2019 on the allocated land with an area of 484 m^2, the land was divided into 4 rice fields, each field area was 100 m^2 with dimensions 10m×10m and each rice field is surrounded by a trench with a depth of 80-90 cm and a width of 50 cm. Watering and filling of trenches were done from the water of the Tigris River inside Baghdad University, all the way to the site of the experiment.

Cultivation of rice

The four rice fields were cultivated in the summer season 2019 in the dry way and by using the seeds of Yasamin (*Oryza sativa*), the cultivation was done by making straight lines with distance between one line and another was 20 cm . after the height of the rice reached 20 cm, the immersion phase began.

Fish experiment

After reaching to the stage of submerging the four fields with water. common carp were obtained from a fish farm south of Baghdad , the fish were transported from the farm to the University of Baghdad by pickup equipped with a pump to circulate the water with the placing of ice to cool the water and reduce its temperature and reduce stress on fish, then the fish were selected at a rate of 50 ± 3 g/fish using an electronic scale and transferred to the rice fields by the use of plastic tank which contained water from a rice field and stayed in the tank for 10 minutes, after which the fish were placed in rice fields.

The design of experiment

The experimental fish were distributed at a weight of 50 ± 3 gm/fish, as the fish were placed in the four treatments by stocking densities: 0, 50, 100 and 150 fish/ rice field.

The studied traits of fish productivity

1. Total Weight Gain (TWG) (Uten, 1979)

   T.W.G. = Final weight – Initial weight

2. Daily Growth Rate (DGR) (Jobling, 1993)

   D.G.R. = (Final weight – Initial weight)/days

3. Survival rate % (Carlos, 1988)

   Survival rate % = (number of fish at the end of the experiment/number of fish at the beginning of the experiment) × 100

Statistical analysis

Complete Randomized Design (CRD) was used to analyze the effect of experimental coefficients on the studied traits and used the Statistical Analysis System (SAS), (2012) to analyze the results and the significant differences between the mean traits averages were examined using the Duncan´s polynomial test Multiple Range Test (Duncan, 1955) at the level of significance (0.05) and (0.01) according to the following mathematical model equation.

$$Yij = \mu + Ti + Eij$$

Results and Discussion

The initial weights of common carp (*Cyprinus carpio* L.) fish cultured in rice fields with three different stocking densities 50, 100 and 150 fish/field showed clear convergence for the three treatments and was 49.85, 49.90 and 50.35 gm/fish respectively and with the progress of the experiment period , differences emerged in the weight rates of the stocked fish, as they showed the second treatment fish with the lowest stocking density (50 fish/field) clearly outperforms the third treatment (100 fish/field) and the fourth treatment (150 fish/field) for the final weight ratio attribute, as the second treatment recorded 133.58 gm/fish and the third treatment is 117.13 gm/fish and fourth treatment 82.61 gm/fish after 90 days of culturing the fish in rice fields, which was reflected in the weight gain rate as the results of the current study showed that there were highly significant differences between experimental treatments with different stocking densities, as the second treatment showed significant superiority ($p<0.01$) and recorded 83.73 gm/fish over the third treatment that it reached 67.23 gm/fish, then the fourth which was 32.26 gm/fish. Therefore, this superiority for the second treatment over the third and fourth treatments continued and the third treatment exceeded the fourth treatment for the daily growth rate characteristic during the experiment period. The second, third and fourth transactions recorded a daily growth rate of 0.96, 0.80 and 0.39 gm/day/fish respectively, for a period of 90 days. as for the survival rate, the results showed that the second treatment outperformed significantly ($p <0.05$) as it recorded 100% in the second treatment was followed by the third treatment with a

Table 1: Effect of different stocking densities on final weight, weight gain, daily growth rate and survival rate of common carp cultured in rice fields (mean ± standard error).

Traits Treatments	Initial weight / gm / fish	Final weight / gm / fish	Weight gain / gm / fish	Daily growth rate (gm / day / fish)	Survival rate %
100.00 a	0.96 ± 0.01 a	83.73 ± 0.23 a	133.58± 0.58 a	49.85± 0.35 a	T2 (50 fish/field)
92.00 b	0.80 ± 0.01 b	67.23 ± 0.35 b	117.13± 1.55 b	49.90± 1.50 a	T3 (100 fish/field)
90.00 b	0.39 ± 0.06 c	32.26 ± 0.16 c	82.61± 0.40 c	50.35± 0.55 a	T4 (150 fish/field)

The different letters vertically indicate that there are significant differences between the averages of the studied trait, while the similar letters vertically indicate the absence of significant differences between the averages of the same trait.

92% survival rate, and then the fourth treatment with a 90% survival rate table 1.

From the review of the results of fish growth traits in the current study it is clear that there is an increase in fish weights rates in all studied treatments with the progress of the experiment period taking advantage of the food provided or the natural food available in the rice fields resulting from the decomposition of fish waste and the food residues and leaves falling in the water of the rice field that provides an environment suitable for fish culture . Results showed the effect of common carp stocking with different densities in rice fields 50, 100, 150 fish/field the superiority of the second treatment (50 fish/field) on third treatment (100 fish/field) and fourth (150 fish/field) in the traits of : average weight fish, weight gain and daily growth rate. The high growth rates in the second treatment fish with lowest stocking density may be due to the access of the fish of this treatment to the food the review of the results of growth traits in the current study it is clear that there is an increase in fish weights rates in all studied treatments with the progress of the experiment period taking advantage of the food provided or the natural food available in the rice fields and the result of the decomposition of fish waste and the food residues and leaves falling in the water of the rice field that provides an environment suitable for fish culture. Results showed the effect of common carp stocking with different densities in rice fields 50, 100, 150 fish/field than the second treatment (50 fish/field) on third treatment (100 fish/field) and fourth (150 fish/field) in adjectives average weight fish, weight gain and daily growth rate. The high growth rates in the second treatment fish with lowest stocking density may be due to the access of the fish of this treatment to the food provided and natural comfortably and in more quantities and thus obtain a higher protein percentage compared to the third and fourth treatments. Thus the fish size gradually increased with the progress of experiment and the failure of all fish in high stocking densities to obtain enough food provided or natural as a result of crowding out and competition among the stocked fish for food and the available location as well as the deterioration of the quality of rice water field with the progress of experiment and low concentration of dissolved oxygen as a result of throwing fish waste in high stocking density which fish strain, and this is consistent with the results of Sen *et al.,* (2010) when using an integrated culture pond between Nile tilapia (*Oreochromis niloticus*) and rice yield of an area of 209 m^2 with densities of 3 fish/m^2 in the first field and 5 fish/m^2 in the second field for 80 days with the use of additional food for cultured fish, the higher growth rates are evident in the lower stocking densities of cultured fish. this was confirmed by several studies, where Mridha *et al*., (2014) found a decrease in the rate of weight increase with high stocking density when culturing Nile tilapia in rice fields with three different densities 4000, 5000 and 6000 fish/ha. Istiaque *et al.,* (2014) reported the production of common carp size increased in low stocking density because there is less competition for food and the place available, as well as less competition for dissolved oxygen, while Billah *et al.,* (2020) noticed that the cultured common carp increased in size in low stocking density because there is less competition for food and the place available, as well as less competition for dissolved oxygen. Billah *et al.,* (2020) when they cultured common carp in rice fields at the area of the field is 15 m^2 in 105 day experiment with stocking densities of 60, 90 and 120 fish/field with an initial weight of 25 gm/fish, without the use of additional food, the best weight gain achieved at the stocking density of 90 fish/field 63.63 g/fish compared to the stocking densities of 60 and 120 fish/field and reached 44.60 and 57.86 g/fish, respectively, while the results indicated that there is an inverse relationship between the fish survival rate and the stocking density, Perhaps the losses that appeared in the experiment are due to several reasons including the changing in fish environment to a new environment represented by the rice field and the decrease in the depth of water in the trenches and the area occupied by rice compared to the earthen ponds or floating cages, especially affected by the difference in temperatures between night and day as well as crowding of fish in a limited space as the rate of declines was

increasing with high densities due to the deterioration of water quality and the gradual decrease in the concentration of dissolved oxygen as a result of disposal of fish waste in high densities, as well as competition for place and food within the rice fields. this is consistent with what mentioned by Rothuis *et al.,* (1998) that the increased stocking density of the Nile tilapia *(Oreochromis niloticus)* in rice fields when fatalities increased . This was confirmed by Stickney (2000) when he explained that higher densities result less survival rates than lower fish stocking density and the reason may be due to congestion in the area units and competition for food and accumulation of fish waste and low concentrations of dissolved oxygen which leads to fatalities. Mridha *et al.,* (2014) claimed a decrease in fish survival rate with an increase stocking density of fish Nile tilapia (*Oreochromis niloticus*) with three different densities 4000, 5,000 and 6000 fish/ha. this was in agreement with the results of Billah *et al.,* (2020) when culturing common carp (*Cyprinus carpio* L.) in rice fields area of the field is 15 m^2 in 105 day experiment with stocking densities of 60, 90 and 120 fish / field without adding any supplementary food , the best survival rate of the fish was achieved at the stocking density 60 and 90 fish/field as it reached 75.00 and 75.92%, respectively, compared to stocking density 120 fish/field with a survival rate 65.55%.

Conclusion

The study concluded the possibility of applying system fish culture common carp (*Cyprinus carpio* L.) in rice fields in Iraq with stocking density of 50, 100 and 150 fish/100 m^2, optimum stocking density is 50 fish/100 m^2, which gave the best survival rate and growth criteria, as this system of culture is a safe and environmentally friendly as it reduces the use of chemical fertilizers that negative impact on the health of farmers and consumers and take advantage of fish waste and unused food residues as fertilizer organic leads to improved soil properties.

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